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Journal of HIV and AIDS
ISSN 2380-5536 | Open Access

RESEARCH ARTICLE

Volume 4 - Issue 2 | DOI: http://dx.doi.org/10.16966/2380-5536.152

HIV and Depression: A Potential Role for Attention Training in Prevention and Treatment

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Received: 03 Mar, 2018 | **Accepted:** 21 Mar, 2018 | **Published:** 27 Mar, 2018

Citation: Houston E, Argueta C, Shoptaw S (2018) HIV and Depression: A Potential Role for Attention Training in Prevention and Treatment. J HIV AIDS 4(2): dx.doi.org/10.16966/2380-5536.152

Abstract

Much research indicates a strong relationship between depressive symptoms and poor health behaviors, including those key to HIV infection and unfavorable treatment outcomes. Given the role of attention bias for negative stimuli in the development and maintenance of depressive symptoms, attention bias modification (ABM) training has gained growing support as a promising clinical approach. ABM is a computerized treatment designed to induce changes in mood and behavior by retraining an individual's attentional focus. Using explicit instructions and trial-by-trial feedback, this preliminary study explored the potential utility of a single session of ABM training in addressing depressive symptoms among individuals at heightened vulnerability for poor HIV-related health behaviors. The sample, recruited from a clinic that provides services to residents of a Los Angeles community impacted by high HIV infection rates, consisted of 14 African American men who have sex with men (MSM). Participants exhibited a significant reduction in attention bias for negative emotional stimuli following a single session of attention training. Engagement with negative stimuli was lower after training than before training regardless of trial type. This study suggests that brief attention training sessions using novel procedures designed to enhance the learning experience of participants could be employed to address depressive symptoms among individuals at risk for poor HIV-related health behaviors. Future studies should employ these procedures as part of multi-session attention trainings with repeated measures of attention bias and depressive symptoms.

Keywords: Depression; HIV; Antiretroviral therapy adherence; Health

Introduction

Depressive symptoms have long been associated with a range of poor health behaviors, including drug and alcohol abuse, increased smoking, and either overeating or restricting food intake [1-3]. In the context of HIV, research suggests a strong link between depressive symptoms and sexual behaviors that put individuals at risk for infection [4-6]. In addition, for many people diagnosed with HIV, depressive symptoms represent a major factor in delayed treatment initiation, suboptimal adherence, and inconsistent engagement with medical care [7-10]. Thus, targeting and reducing depressive symptoms in vulnerable populations has substantial potential for improving a number of HIV-related outcomes.

Cognitive theories of depression propose that an individual's risk for depression and depressive symptoms is heightened by a tendency to selectively attend to and process negative stimuli [11-14]. Attention training, such as attention bias modification (ABM), has shown much promise as an approach for altering attention bias associated with negative mood states [15-18]. In ABM training, participants are presented with a modified dot-probe task composed of numerous, repetitive trials. In each trial participants are asked to watch a fixation cross situated in the center of a computer screen for a very brief period (e.g., 500 ms). The fixation cross is immediately followed by a screen depicting two emotionally-valenced or neutral stimuli (words, images, or faces). Stimuli appear simultaneously on opposite sides of the screen for a short duration, typically 500–1000 ms, before a subsequent screen showing only the probe in the location that had been occupied by one of the stimuli. At this time, participants must indicate the location of the probe as quickly as possible.

In ABM, the probe appears in the location of neutral or emotionally positive stimuli nearly always (e.g., 90% of the time), thereby training participants to learn to shift their attention toward these types of stimuli. As a result, reaction

times become shorter when the probe follows positive or neutral stimuli compared to the emotionally negative stimuli, which generally have greater salience to people with depressive symptoms. Research indicates that with repeated trials, depressed individuals' attention bias toward negative stimuli is reduced as a consequence of learning to redirect or retrain attentional focus toward neutral or positive stimuli.

ABM procedures have demonstrated efficacy as a treatment for depression, with studies showing a 40-50% reduction in depressive symptoms after two to four weeks of ABM training [15,16]. In addition, ABM sessions are brief (e.g., 10 to 15 minutes) and training period lengths have generally ranged from 10 days to four weeks [19,20]. The effects of a single session of attention training, however, have been mixed [e.g., 21-24].

Evidence from several studies suggests that the utility of single-session attention training may be strengthened through strategies that enhance the learning experience of individuals participating in such interventions [20,22,25,26]. Guided by goal setting theory, these strategies include providing participants with explicit instructions, a clear statement of the training goal, and trial-by-trial feedback on performance (e.g., reaction time changes; response accuracy rate). Relative to participants in attention training studies based on standard implicit administration, findings indicate that participants who receive explicit instruction demonstrate greater reductions in negative attention bias and psychological distress [26-29].

The purpose of this preliminary study was to explore how a single session of attention training enhanced with explicit instruction strategies may affect attention bias toward negative stimuli among individuals at heightened vulnerability for HIV risk behaviors or poor treatment engagement. The study, therefore, used a small sample of African American men who have sex with men (MSM), a population group disproportionately affected by both depressive symptoms as well as the HIV epidemic [30-32].

Method

Participants

Data were derived from a sample of 14 participants who were recruited through flyers distributed by outreach workers and staff from a clinic that provides medical care and social services to residents of a Los Angeles community disproportionately impacted by the HIV epidemic. Participants were recruited if they met they following criteria: (1) African-American male; (2) 18 to 65 years old; (3) self-identified as MSM.

Measures

Demographics: Participants provided basic demographic data by completing a 12-item questionnaire designed to obtain information on age, ethnicity, education, employment, income, and HIV serostatus.

Depressive symptoms: Depressive symptoms were measured using the Patient Health Questionnaire-9 [PHQ-9] [33]. The PHQ-9 is a well-validated and widely-used brief instrument for assessing and monitoring depression severity. Depression scores derived from the PHQ-9 correspond to minimal (≤ 4), mild (5–9), moderate (10–14), moderately severe (15–19), or severe (≥ 20). Based on systematic reviews and a meta-analysis of the PHQ-9, a cutoff score of 10 or greater has been described as indicative of meeting diagnostic criteria [34,35]. The instrument has a Cronbach's alpha of .91. The PHQ-9 was employed to assess the relationship between negative attention bias and a range of depressive symptoms.

Attention bias: To measure attention bias for emotionally negative stimuli before and after attention training, we used the dot-probe task on a desktop computer with OpenSesame software [36]. In the dot-probe task, participants were presented on a computer screen with two pictures, one emotionally negative and the other positive or neutral. Pictures used as stimuli were selected from the Geneva Affective Picture Database [GAPED] [37], a database consisting of visual stimuli used in psychology and neuroscience for emotion research. GAPED stimuli include pictures with negatively-valenced emotional content (e.g., spiders, snakes, animal mistreatment and human mistreatment), positively-valenced emotional content (e.g., landscapes, human and animal babies as well as nature sceneries) and neutral content (e.g., buildings, furniture, other inanimate objects).

Attention bias was assessed during test sessions consisting of 200 dot-probe trials conducted immediately before and after attention training. Each trial began with the appearance of a white fixation cross on black background for 500 ms followed by a screen showing a stimulus pair with duration of 500 ms as well. Stimulus pairs were presented randomly as was the position of the negatively-valenced vs. positively-valenced/neutral pictures on the screen (right or left). After stimulus pair offset, a dot-probe appeared on the left or right side of the visual field. In all trials used to assess attention bias, the dot-probe targets appeared with equal probability in the negative (50%) and positive/neutral (50%) picture positions. Attention bias scores were calculated for each participant using the following equation:

$$\text{Attention bias score} = \tfrac{1}{2}\left[(RpLe + LpRe) - (RpRe + LpLe)\right]$$

where R=Right position, L=Left position, p=probe, and e=emotional stimulus (negative picture).

The attention bias score, a calculation of the reaction time based on the location of the probe and the negative picture stimulus, represents the extent to which a participant's attention is absorbed by the negative picture. Higher scores reflect an attention bias toward negative stimuli whereas negative scores reflect avoidance or shifting of attention away from these stimuli.

We also calculated participant reaction times in identifying the location of the probe during pre- and post-training dot-

probe tasks based on whether the trial type was congruent or incongruent. Congruent trials were those in which the probe replaced the negative stimulus. Incongruent trials were those in which the probe replaced the positive/neutral stimulus. We calculated reaction times for both types of trials to better capture the processes influencing participants' attention bias. Faster reaction times tend to characterize congruent trials whereas slower reaction times characterize incongruent trials. Faster reaction times based on whether a trial is congruent versus incongruent may reflect the degree to which a participant is engaged with negative emotional stimuli. Reductions in reaction time may also indicate improved cognitive control, the ability to adapt flexibly in response to a given set of goals.

Attention Bias Modification Training

Stimuli used in attention training consisted of those used during the dot-probe task to assess attention bias before and after training. To train the attention of participants from negative to positive/neutral stimuli, however, we used a modified version of the dot-probe task. In the modified dot-probe task, 90% of the dot-probe targets appeared at the screen position that had been occupied by the positive/neutral picture whereas 10% appeared in the position that had been occupied by the negative picture position. Each trial started with the appearance of a white fixation cross on a black background positioned in the middle of the screen for 500 ms followed by a stimulus pair that was also presented for 500 ms before the appearance of the dot-probe. Participants heard a beep when they failed to identify the correct location of the dot-probe during each trial.

Procedure

After being administered informed consent, participants completed a brief demographic questionnaire and a measure to assess depressive symptoms in a clinic office used by research staff. Participants were provided an explanation of attention training procedures and explicit instructions in which both speed and accuracy were emphasized. Instructions were provided both on screens for the attention training program as well as directly from research staff. Prior to completing attention bias assessments and beginning the attention training program, participants received a tutorial practice session on the use of the ABM program. In the practice session, participants were presented with 10 stimulus pairs from GAPED. Stimuli used in the practice session were not repeated during the assessment or training sessions.

Participants received immediate feedback on their performance during the practice session in the form of a beep that was activated whenever they failed to identify the correct location of the dot-probe during each trial. The dot-probe remained in the visual field until participants entered a response. At the completion of the practice session, participants were presented with a screen that showed their reaction time and accuracy rate. Research staff reviewed these performance measures with the participant. To ensure they understood how to use the computerized program, participants were required to have an accuracy rate of 80% before proceeding. Trial-by-trial feedback in the form of beep sounds was also provided during attention training, which consisted of four blocks of 50 trials. At the end of each round of training, participants were presented with a screen that showed their reaction time and accuracy rate for that specific training session. Participants received and reviewed these performance measures with research staff after each training block. Pre- and post-training assessments were conducted without trial-by-trial feedback. Performance measures were provided to the participants only upon completion of all trials in the pre- and post-training assessments. Participants were compensated with $20 for their time upon completing the computerized assessments and training. All procedures for recruitment, data collection and confidentiality were reviewed and approved by the Institutional Review Board at Charles R. Drew University of Medicine and Science.

Data Analytic Strategy

Data analysis was performed using IBM SPSS 22.0. Due to the small sample size and non-normal distribution of the reaction time data, we used two nonparametric statistical methods, the Wilcoxon signed-rank test and the Mann–Whitney *U* test, to analyze changes in attention bias scores. For the analysis of attention bias, we included reaction times only from correct responses, thereby resulting in a loss of 27 trials, approximately 0.5% of data. To reduce the influence of outliers, we eliminated reaction times that were 1.5 standard deviations above or below the mean response time for a participant. Reaction times from a total of 701 trials were outside these limits and consequently removed as candidates for subsequent data analyses. This represented a loss of 12.5% of data. Exclusion criteria employed in this study are consistent with those used in other published research [38]. We also excluded participants with HIV-negative serostatus from analyses involving reaction time data due to their relatively small numbers in the sample (n=2) and evidence that HIV may put individuals at heightened risk for longer reaction times [39]. The alpha level for all statistical tests was set at 0.05.

Results

Sample description

Participants (n=14) reported a mean age of 47 years (SD=10.3). Nearly two-thirds indicated that they had graduated from high school (n=9; 64%) while five participants reported having attended some college or vocational school (n=5; 36%). Slightly more than 71% (n=10) of the sample reported an annual mean income of $20,000 or less, with the remainder reporting an income between $20,000 to $60,000. More than half reported being on disability (n=8; 57%). Most participants were HIV seropositive (n=12; 86%).

Depressive symptoms

The mean PHQ-9 score for the sample was 10.2 (*SD*=7.8). This mean score, which falls in the moderate range with regard to depressive symptoms severity based on the PHQ-9, was slightly above the cutoff used to suggest diagnostic criteria for major depression. Half of all participants had a score at or above the diagnostic cutoff of 10. Three study participants reported suicidal ideation. Participants who screened as having suicidal ideation received further risk assessments followed by steps to ensure their safety and referrals for mental health care. Overall, three participants (21%) had depression scores in the mild range, six (43%) in the moderate to moderately-severe ranges, and one (7%) in the severe range. Four participants (29%) reported depressive symptoms in the minimal range.

Reaction times: congruent versus incongruent trials

We assessed participant reaction times in identifying the location of the dot-probe during congruent and incongruent trials. As shown in table 1, participants demonstrated significantly faster reaction times after attention training than before attention training for both congruent trials (z=-2.197, p=.028, effect size=.66) as well as incongruent trials (z=-2.432, *p*=0.015, effect size=.73).

Median reaction times during congruent trials following attention training declined by 11% after completing brief training sessions that ranged in duration from 12 to 15 minutes. For incongruent trials, median reaction times dropped by nearly 14% after these brief training sessions. There were no statistically significant differences in reaction time among participants based on the PHQ-9 diagnostic cutoff for depressive symptoms.

Changes in attention bias

Participants demonstrated a significant reduction in negative attention bias from pre-training to post-training as assessed by the dot-probe task (*z*=-2.432, *p*<.05, effect size *r*=0.73). Overall, 83% of the attention bias scores analyzed indicated that participants gained an improved ability to shift attention away from emotionally negative stimuli. The median pre-training attention bias score for participants was 12.79 (IQR=34.95). The median post-training attention bias score was -3.11 (IQR=22.15). Figure 1 provides a visual illustration of these findings. There were no statistically significant differences among participants based on whether they were above or below the diagnostic cutoff for depressive symptoms according to the PHQ-9.

Table 1: Dot-Probe Reaction Time (ICQ) to Negative Stimuli Presented Pre- and Post-Training by Trial Type

Trial Type	Assessment Time		Test Statistic	p*
	Pre-training	Post-training		
Congruent	1,272.98 (412.57)	1,131.22 (428.2)	-2.19	0.028
Incongruent	1,307.85 (396.5)	1,131.26 (351.4)	-2.43	0.015

Note: ICQ: Interquartile range; Reaction times reported in milliseconds
*p values determined by Wilcoxon signed-rank test

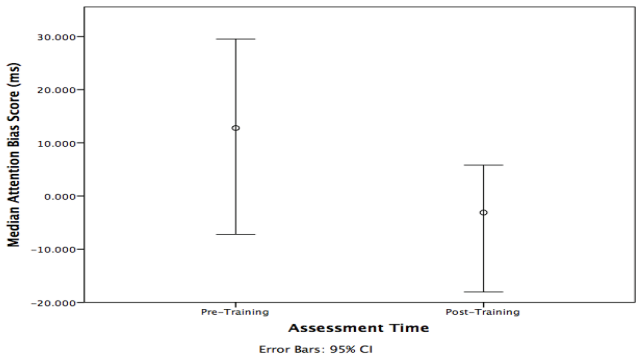

Figure 1: Attention bias scores (in milliseconds) from the dot probe task at Pre-Training (before ABM) and Post-Training (after ABM).

Discussion and Conclusions

Much literature has demonstrated the role of depressive symptoms as barriers to the consistent exercise of self-care health behaviors in the HIV context, including sexual risk reduction, early initiation of antiretroviral therapy, and routine engagement with medical care. This preliminary study represents the first to evaluate the potential of ABM in addressing the cognitive factors underlying depressive symptoms among individuals at high risk for poor HIV health-related behaviors.

We recruited participants disproportionately affected by the HIV epidemic in the U.S. and who reported a range of depressive symptoms, from minimal to severe. Our findings showed that participants who completed a single session of ABM training experienced significant reductions in their attention bias for negative emotionally-valenced stimuli. Such a finding is important particularly given a recent review indicating that negative attention bias reduction is critical for subsequent symptom reduction [40]. In addition, for both congruent and incongruent attention training trials, reaction time measures indicated that participants experienced reductions in their tendency to engage with negative emotional stimuli by as much as 14% after completing a single training session of approximately 12 to 15 minutes. Overall, given the links between negative attention bias and depressive symptoms, our findings suggest that ABM training may have much potential as a time-limited, cost-effective intervention aimed at reducing negative attention bias, a key factor associated with depressive symptoms. Further research is needed to better understand how various levels of negative bias reductions relate to clinically significant changes in depressive symptoms. While not directly examined in this preliminary study, such a reduction in negative attention bias could subsequently mitigate a tendency toward poor HIV-related health behaviors. Future research should be conducted to develop attention training interventions that address cognitive processes related to both depressive symptoms and HIV health behaviors.

Findings from this study add to the growing body of research evidence in support of ABM as a promising clinical intervention [15-18,25-29]. The computerized format of ABM and its indirect delivery of treatment with few demands on the individual, suggests that it has much potential as a brief, effective intervention aimed at hard-to-reach populations. While MSM are disproportionately affected by depression, anxiety, and other mental health problems, there have been no ABM studies to date that target this population group, which is also significantly burdened by the HIV epidemic. Further research is needed to examine how ABM could play a role in addressing disparities related to HIV as well as a range of mental and physical health conditions.

Our study provides additional support for the use of novel ABM procedures to consistently maximize the effectiveness of single session attention trainings as recommended by several investigators [20,25,26,40-42]. While the research literature has been mixed with regard to the outcomes of single session attention trainings, our findings and those of others suggest that brief training sessions could benefit from the employment of novel procedures designed to enhance the learning experience of participants. In this study, we employed several of these recommended procedures, including providing participants with explicit instructions, giving them a clear statement of the training goal, and incorporating trial-by-trial feedback on their performance.

Given the findings of the present study, it is important that future single session attention training research pursue new directions. A significant methodologic weakness of this preliminary study was the lack of a comparison group. A comparison group should be incorporated into future research designs to better assess the extent to which changes such as those we observed were due to ABM per se. The generalizability of the study's findings is limited due to the use of a small sample consisting primarily of HIV seropositive men with a mean age of 47. Future studies should enroll younger participants and include sufficient numbers of HIV seronegative participants as well. Another limitation of this study was that it contained trials in which negative stimuli were paired with either neutral or positive stimuli, thereby restricting our ability to assess changes in participant engagement with positive stimuli. Future studies should incorporate trials that address this limitation.

While our goal was to explore how the use of explicit instruction strategies could maximize the effectiveness of a single attention training session, future studies should employ these procedures as part of multi-session attention trainings with repeated measures of attention bias and depressive symptoms to assess how they enhance participant learning experiences. Future studies should be designed to address both attention biases that trigger and maintain depressive symptoms as well as favor avoidance of HIV treatment or the adoption of HIV preventive behavior, including consistent condom use, regular testing, adoption of pre-exposure prophylaxis (PrEP), a promising new HIV prevention method that has had poor uptake among population groups disproportionately affected by the HIV epidemic in the U.S. Based on both theory and empirical evidence, the cognitive processes and thoughts associated with individual mood states and behaviors are likely to overlap. Future studies should focus on how the assessment of these processes could be incorporated into attention trainings.

Acknowledgments

Dr. Houston is supported by a grant from the National Institute on Minority Health and Health Disparities (S21 MD000103; Sustaining Faculty Development and Community Engagement; David M. Carlisle, M.D., Principal Investigator). This research was supported by Grant 5U54MD007598 from NIMHD to Accelerating Excellence in Translational Science (AXIS) at Charles R. Drew University of Medicine and Science (Jaydutt V. Vadgama, Ph.D., Principal Investigator). The content is solely the responsibility of the authors and does not necessarily represent the official views of NIMH or the NIH. The authors would like to thank Christopher Beevers, Felipe Findley, Charles Hilliard, David Lee, and Gregory D. Victorianne for their assistance and support in completing this report.

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